



Chapter Fourteen

INTERSECTION DESIGN STUDIES

BUREAU OF DESIGN AND ENVIRONMENT MANUAL

Chapter Fourteen
INTERSECTION DESIGN STUDIES

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CHAPTER FOURTEEN

INTERSECTION DESIGN STUDIES

An intersection design study (IDS) is a graphic representation of a proposed treatment for the development or improvement of an intersection facility. It is based on an analysis of traffic needs and an evaluation of physical and economic elements at the intersection site. Chapter 14 presents the Department's criteria for the preparation of an IDS. Chapter 36 presents the detailed design criteria for intersections.

The primary purpose of an IDS is to provide a review medium for use by the district, BDE, and the general public. The IDS also provides a file reference that documents all pertinent data and information controlling the design of the intersection improvement.

14-1 WARRANTS FOR THE PREPARATION OF INTERSECTION DESIGN STUDIES

Prepare an IDS for intersections if any of the following conditions apply:

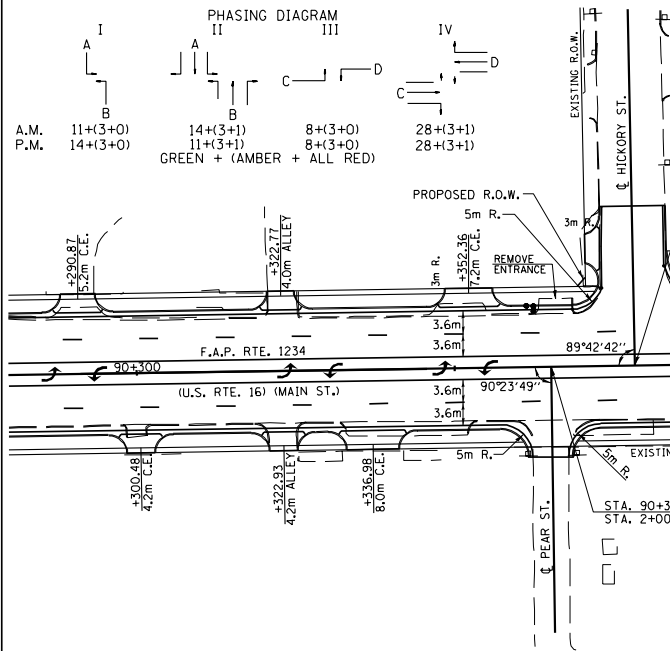
- The study location is an intersection of two marked routes.
- The improvement is intersected by either:
 - + a rural highway that has an existing 30th maximum hourly volume greater than 300 vehicles or additional lanes and/or channelization is proposed on one or both routes; or
 - + an urban highway that has an existing 30th maximum hourly volume greater than 400 vehicles or additional lanes and/or channelization is proposed on one or both routes.
- Where complex conditions exist at the intersection (e.g., high crash rate, adverse terrain features, geometric features that will be difficult to correct due to the extent of cultural development).
- When requested by the district or BDE in accordance with the engineering study and advance engineering data requirements in the *ILMUTCD*.

14-2 PREPARATION OF INTERSECTION DESIGN STUDIES

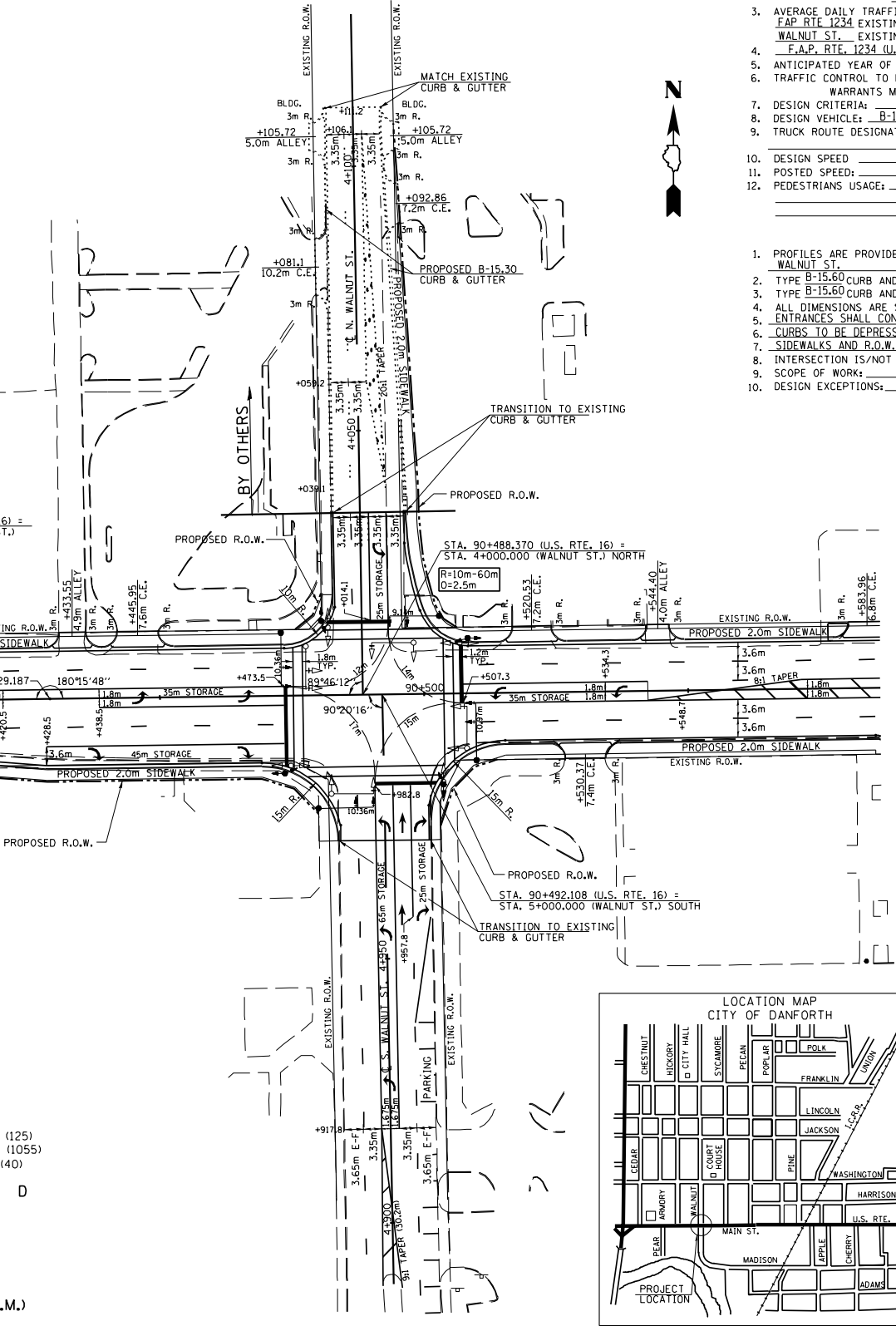
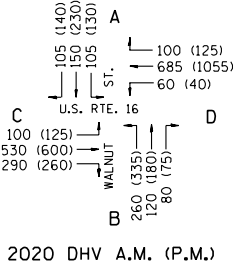
Prepare IDS plan sheets on CADD. For guidance on the preparation of plan or profile sheets, see Chapter 63. To facilitate uniformity, use the following sheet formats:

1. Sheet No. 1. An example of a Layout Sheet No. 1 is illustrated in Figure 14-2A. In urban areas, the intersection layout is usually drawn at a scale ratio of 1 in = 50 ft (1:500 metric) and in rural areas 1 in = 100 ft (1:1000 metric) or 1 in = 50 ft (1:500 metric). Sheet No. 1 is the cover sheet and contains the following items:
 - capacity analysis table,
 - turning movement diagram,
 - traffic data table,
 - north arrow,
 - data block for elements controlling design,
 - phasing diagram,
 - location map box,
 - general notes block, and
 - signature and title block in the lower right-hand corner.
2. Sheet No. 2. Sheet No. 2 is a supplemental sheet for intersection details. Depending on the complexity of the intersection and the need to show special details or cross sections, this sheet may not be required. In urban areas, the scale ratio is usually 1 in = 20 ft (1:250 metric) and in rural areas 1 in = 50 ft (1:500 metric). Also include the following items on the sheet:
 - title block in the lower right-hand corner; and
 - sheet index block in the upper right-hand corner indicating the route, section, county, and sheet numbers.
3. Sheet No. 3. Sheet No. 3 is a typical grid sheet for showing profiles. Use the format illustrated in Figure 14-2B. Also include the following items on the sheet:
 - title block in the lower right-hand corner; and
 - sheet index block in the upper right-hand corner indicating the route, section, county, and sheet numbers.

CAPACITY DESIGN ANALYSIS											
4 PHASE		AREA		OTHER		PEAK HOUR FACTOR		0.95			
75 SEC. CYCLE		AVERAGE INTERSECTION DELAY		PROGRAM USED		HCS-VERSION 2.4C		A.M. 13.5 SEC.		P.M. 23.1 SEC.	
SIGNAL TYPE		ACTUATED						INTERSECTION LEVEL		OF SERVICE	
APPROACH		A		B		C		D			
BUS STOP CONDITION											
PARKING MANEUVER/HR.											
PEDESTRIANS		50		50		50		50			
ARRIVAL TYPE		3		3		3		3			
LANE UTILIZATION FACTOR		1.00		1.00		1.00		1.00		1.00	
BASE SATURATION FLOW		1900		1900		1900		1900		1900	
D - DISTANCE		25m		65m		25m		35m		45m	
LANE GROUP		L		L		R		L		R	
LANE WIDTHS		3.35m		2x3.35m		3.35m		3.35m		3.6m	
GREEN TIME (SECONDS)		A.M. 11.0		14.0		11.0		14.0		8.0	
P.M.		14.0		11.0		14.0		11.0		8.0	
LANE GROUP DELAY (SECONDS)		A.M. 10.4		17.9		16.3		17.6		17.2	
P.M.		10.9		28.1		30.5		26.5		19.1	
V/C RATIO		A.M. 0.26		0.45		0.73		0.38		0.30	
P.M.		0.35		0.83		0.91		0.73		0.36	
LEVEL OF SERVICE		A.M. B		C		C		C		B	
P.M.		B		D		D		D		B	
2020 30TH MAX. HOUR TRAFFIC		A.M. 105		255		260		120		80	
P.M.		130		370		335		180		75	
2000 8TH MAX. HOURLY TRAFFIC		A.M. 151		198		421		388			
P.M.		204		253		451		567			



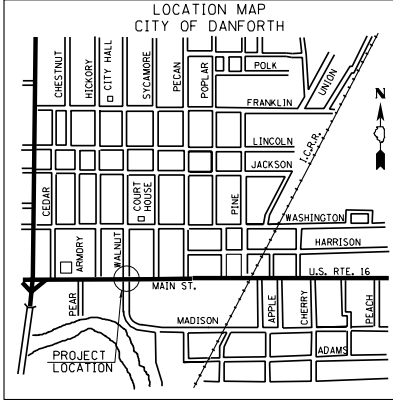
TRAFFIC DATA											
MOVE- MENT	YEAR 2000 30TH MAXIMUM HOUR TRAFFIC		PERCENT TRUCK TRAFFIC IN 30TH MAX HOUR	ESTIMATED PERCENT INCREASE BY	YEAR 30TH MAXIMUM HOUR TRAFFIC		ESTIMATED PERCENT INCREASE BY	YEAR 2020 30TH MAXIMUM HOUR TRAFFIC		ESTIMATED PERCENT INCREASE BY	
	A.M.	P.M.			A.M.	P.M.		A.M.	P.M.		
AB	115	165	3					150	230		
AD	80	100	3					105	130		
AC	80	105	3					105	140		
BA	100	150	3					120	180		
BC	200	260	3					260	335		
BD	60	50	3					80	75		
CD	460	520	5.2					530	600		
CA	80	100	5.2					100	125		
CB	225	200	5.2					290	260		
DC	585	900	5.3					685	1055		
DB	40	30	5.3					60	40		
DA	80	100	5.3					100	125		
TOTAL A	535	720	2000 ADT=6,900					2020 ADT=8,900	680	930	
TOTAL B	740	855	2000 ADT=9,500					2020 ADT=12,400	960	1120	
TOTAL C	1630	2085	2000 ADT=22,700					2020 ADT=27,000	1970	2515	
TOTAL D	1305	1700	2000 ADT=18,700					2020 ADT=21,500	1560	2025	



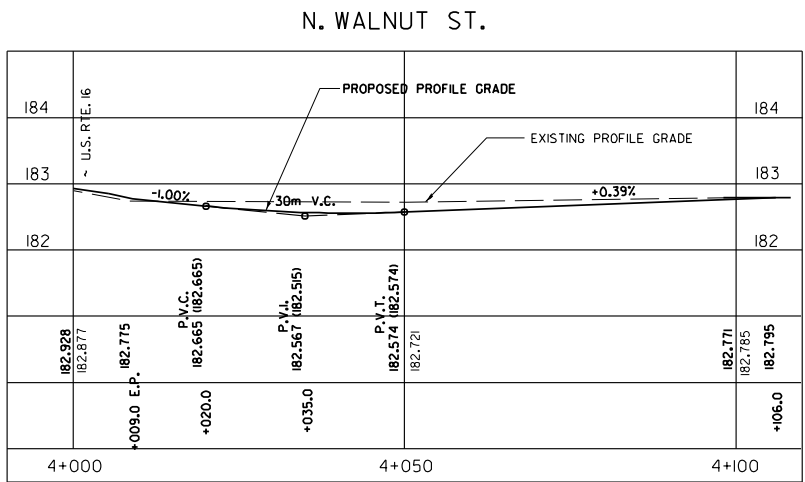
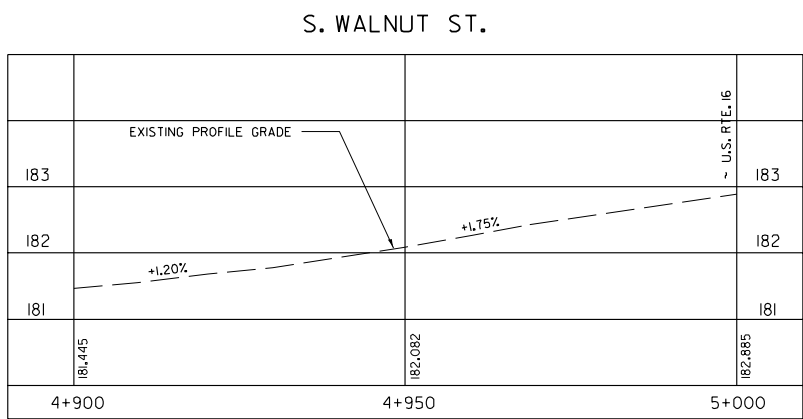
ELEMENTS CONTROLLING DESIGN	
1. ROUTE (STREET)	F.A.P. RTE. 1234 (U.S. RTE. 16/MAIN ST.) WITH WALNUT ST.
2. HIGHWAY FUNCTIONAL CLASSIFICATION	US RTE 16 - PRINCIPAL ARTERIAL WALNUT ST. - URBAN COLLECTOR
3. AVERAGE DAILY TRAFFIC (ADT) DATA:	
FAP RTE 1234 EXISTING	22,700 (2000) DESIGN 27,000 (2020)
WALNUT ST. EXISTING	9,500 (2000) DESIGN 12,400 (2020)
4. F.A.P. RTE. 1234 (U.S. RTE. 16/MAIN ST.) IS THE PREFERENCE ROUTE	
5. ANTICIPATED YEAR OF CONSTRUCTION	2000 DESIGN YEAR 2020
6. TRAFFIC CONTROL TO BE	TRAFFIC SIGNALS. EXISTING SIGNALS ARE TO BE MODERNIZED.
WARRANTS MET	WARRANT 1
7. DESIGN CRITERIA:	W & RS
8. DESIGN VEHICLE:	B-12 NORTH, WB-15 SOUTH
9. TRUCK ROUTE DESIGNATION	US 16 IS CLASS II
	U.S. RTE. 16 WALNUT ST.
10. DESIGN SPEED	60 km/hr 60 km/hr
11. POSTED SPEED:	35 MPH 35 MPH
12. PEDESTRIANS USAGE:	YES BICYCLES USAGE: NA

GENERAL NOTES	
1. PROFILES ARE PROVIDED, SINCE APPROACH GRADES ARE	GREATER THAN 1.0 PERCENT ON WALNUT ST.
2. TYPE B-15.60 CURB AND GUTTER TO BE USED ON OUTER EDGES OF PAVEMENT.	
3. TYPE B-15.60 CURB AND GUTTER TO BE USED ON CHANNELIZING ISLAND.	
4. ALL DIMENSIONS ARE SHOWN E-E OF PAVEMENT UNLESS OTHERWISE NOTED.	
5. ENTRANCES SHALL CONFORM TO THE POLICY ON "ACCESS TO STATE HIGHWAYS".	
6. CURBS TO BE DEPRESSED AT CROSSWALKS TO MEET ADA.	
7. SIDEWALKS AND R.O.W. ARE SUBJECT TO REVISION DURING PREPARATION OF FINAL PLANS.	
8. INTERSECTION IS/NOT A HIGH ACCIDENT LOCATION - YEAR:	
9. SCOPE OF WORK:	
10. DESIGN EXCEPTIONS:	

IDS Sheet No. 1
Figure 14-2A



DRAWING NO.	
INTERSECTION DESIGN STUDY	
F.A.P. ROUTE 1234 (U.S. RTE. 16) (MAIN ST.)	ROUTE WITH WALNUT ST.)
SEC. NO.(54,432-3)(W,RS-1)(27,19,8,63)(W,RS-1)&35(W,RS-2)	
SCALE 1:500	COUNTY MERIDIAN
SJN #P-90-042-97	REV. NO. 42640
DESIGNED BY	DATE 6/97
SATISFACTORY	DISTRICT GEOMETRICS ENGINEER DATE
SATISFACTORY	DISTRICT PROGRAM DEVELOPMENT ENGINEER DATE
SATISFACTORY	DISTRICT OPERATIONS ENGINEER DATE
APPROVED	DISTRICT ENGINEER DATE
CADD FILE NAME : []	I.D.S. SHEET 1 OF 2



IDS Sheet No. 3
Figure 14-2B

DRAWING NO. _____	
INTERSECTION DESIGN STUDY	
F&P ROUTE 1234	(U.S. RTE. 16) (MAIN ST.)
ROUTE _____	WITH (WALNUT ST.)
SEC. NO. (54,43Z-3)(W,RS)(127,19,8,63)(W,RS-11&35(W,RS-2)	
SCALE 1:50 VERT.	COUNTY MERIDIAN _____
1:500 HORIZ.	
SJN : P-90-042-97	PROJ. NO. 42640
CADD FILE NAME : I _____	I.D.S. SHEET 2 OF 2

14-3 DATA REQUIRED FOR INTERSECTION DESIGN STUDIES

Document the following data in the IDS:

1. Elements Controlling Design. Chapter 36 presents the design criteria for intersections. On Sheet No. 1, list all pertinent elements affecting the design of the intersection including:
 - the intersection route designation including highway functional classification, SRA Route designation, if appropriate, proposed design speed, and existing and design traffic (ADT and year) for both intersecting routes;
 - the preferential route;
 - the anticipated year of construction;
 - the type of traffic control including:
 - + a statement indicating whether signals will be installed or adjusted;
 - + the warrant, or combination of warrants, from the *ILMUTCD* justifying the use of signal control;
 - design criteria;
 - design vehicle;
 - truck route designation;
 - existing and proposed posted speeds (mph) on all intersection approaches (proposed posted speeds should be equal to or less than the design speeds); and
 - pedestrian and bicycle usage at intersection.
2. General Notes. Include the following information in the general notes on Sheet No. 1:
 - a. Grades. Where all existing grades to remain are greater than 1% or in all cases with any new or altered grades, include a statement that profiles are shown for both intersecting roads and show them on Sheet No. 3. If existing grades are to remain and are all less than 1%, indicate this fact and state that no profiles are shown.

- b. Curb and Gutter. Indicate the type of curb and gutter to be used on the outer edges of the traveled way, shoulders, channelizing islands, and corner islands. Only use mountable type curbing on corner islands.
- c. Dimensions. Indicate the type of dimensioning used (e.g., edge-to-edge of pavement, edge-to-edge of traveled way).
- d. Design Exceptions. List any deviations from design criteria (see Section 31-8) and typical traffic control practice (e.g., large truck turning encroachments, lane widths less than Department criteria, less than desirable level of service, less than desirable storage length for queued vehicles, angle of intersection less than 60°). Include the justification for design exceptions in the Phase I report.
- e. Access to State Highways. State if the design complies with the criteria in Section 36-7 or list any instances of noncompliance.
- f. Crashes. Note if the intersection is a high-accident location (HAL) and, if so, what year.
- g. Terrain. Describe any unusual terrain features that could affect the design.
- h. Cultural Development. Indicate adjacent cultural development that influences the intersection layout.
- i. Improvement Type. List the type of improvement (e.g., new construction, reconstruction, 3R, safety).
- j. Bicycle Route. Note the existence of designated bicycle routes through the intersection.
- k. Sight Distance. On two-way stop-controlled intersections, note if intersection sight distance is met.
- l. Verification. Note the method used to verify sufficiency of intersection to accommodate turning movements of the design vehicle.
- m. Right-of-Way. Indicate if proposed right-of-way limits for the intersection are preliminary.
- n. Truck Routes. Note the existence of designated truck routes through the intersection.
- o. Other. Include any additional information not listed elsewhere that will aid in the review of the IDS.

3. Capacity Analysis. Perform and document the capacity analysis of the IDS according to the following guidelines:
 - a. Source Document. Use the *Highway Capacity Manual* and the *Highway Capacity Software* (distributed by the McTrans Center for Microcomputers in Transportation) for the capacity analyses. The use of any other capacity techniques and software must be first approved by BDE; see Section 36-1.07.
 - b. Signal Phasing. In diagrammatic form, illustrate the proposed signal phasing required to obtain the desired level of service. Orient the signal phasing diagram to be consistent with the plan view of the intersection and any other pertinent diagrams.
 - c. Results. Document the data and results of the capacity analysis on Sheet No. 1 for each leg of the intersection in a table as illustrated in Figure 14-3A.
4. Traffic Data. Provide the following traffic data on Sheet No 1:
 - a. Traffic Movements. Provide a tabular listing of all movements to and from each leg of the intersection. Use the format illustrated in Figure 14-3B. Also, prepare a traffic diagram for the design year showing all DHV movements within the intersection. Orient the traffic diagram to be consistent with the plan view of the intersection and any other pertinent diagrams.
 - b. Existing Volumes. Calculate the 8th maximum hourly volume per day from actual traffic counts to determine whether traffic signal warrants are met. See the *ILMUTCD* for additional guidance.
 - c. Proposed Volumes. For new intersections or where proposed intersection improvements for large developments will significantly increase traffic volumes, traffic signals may be justified where the 8th maximum hourly volume three years after construction exceeds the values stated in the warrants. The three years time frame should be increased in the event of staged development. The 8th maximum daily hourly volume may be considered as 55% of the projected 30th maximum hour volume. See the *ILMUTCD* for additional guidance.
 - d. Pedestrians. Where pedestrian control signal heads are proposed, provide a pedestrian count.
5. Intersection Layout and Design. Provide the following intersection layout and design information on Sheets No. 1 and No. 2:
 - a. Centerline. Show the centerline information for all proposed and existing curves within the immediate area of the intersection. Include superelevation rates and transition stations. Label the station equation for all intersecting side roads.

- b. Angle. Note the angle of intersection between the two roadways.
- c. Location Map. Provide a small scale location map, covering a sufficient area to properly identify the location of the improvement. It should portray the existing street or local road network and any municipalities adjacent to the improvement. Layout the map with North in the same direction as shown on the intersection layout.
- d. Auxiliary Lane Lengths. Indicate lengths for all auxiliary lanes.
- e. Tapers. Indicate all taper lengths and rates.
- f. Scales. Provide a bar scale on each sheet.
- g. Topographic Features. Indicate all limiting topographic features or cultural developments including:
- existing and proposed access driveways;
 - existing and proposed right-of-way lines and any access control limits;
 - property lines;
 - property owners, business names, land uses, and buildings;
 - sidewalks, curb ramps, and other accessibility requirements, see Chapter 58; and
 - other factors controlling the intersection design (e.g., retaining walls, utilities, gasoline pumps, other appurtenances).
- h. Signals. Show the proposed signal locations and signal phasing diagram. Prepare these according to the criteria and guidelines presented in Chapter 57. This information is required to ensure compatibility with other design elements, right-of-way, and traffic flow (progression).
- i. Signs. For complex intersections, show the proper placement of signs and traffic control devices. Because signing distance and legend requirements could influence the design of complex facilities, include a preliminary signing plan with the IDS for all complex intersection designs.
- j. Striping. Include the proposed striping details on the IDS.

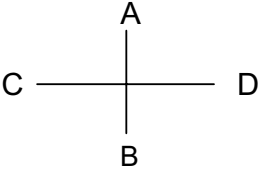
- k. Control Points. Provide the station and offset of all control points, including all island noses, radius return points of curvature and tangency, and centerline or baseline control points.
6. Title Block. Only the individual personally responsible for the intersection design will occupy the "Designed By" line in the title block.

CAPACITY DESIGN ANALYSIS												
____ PHASE ____ SEC. CYCLE SIGNAL TYPE _____		AREA _____ AVERAGE INTERSECTION DELAY A.M. _____ SEC. PROGRAM USED _____ P.M. _____ SEC.				PEAK HOUR FACTOR _____ INTERSECTION LEVEL A.M. _____ OF SERVICE P.M. _____						
APPROACH		A		B		C		D				
BUS STOP CONDITION												
PARKING MANEUVER/HR.												
PEDESTRIANS												
ARRIVAL TYPE												
THROUGH LANE UTILIZATION FACTOR												
BASE SATURATION FLOW RATE												
D-DISTANCE												
LANE GROUP												
LANE WIDTHS												
GREEN TIME (SECONDS)	A.M.											
	P.M.											
G/C Ratio	A.M.											
	P.M.											
LANE GROUP DELAY (SECONDS)	A.M.											
	P.M.											
V/C RATIO	A.M.											
	P.M.											
LEVEL OF SERVICE	A.M.											
	P.M.											
20 ____ 30TH MAX. HOURLY TRAFFIC	A.M.											
	P.M.											
20 ____ 8TH MAX. HOURLY TRAFFIC	A.M.											
	P.M.											

CAPACITY DESIGN ANALYSIS SUMMARY
Figure 14-3A

TRAFFIC DATA									
Movement	Year 20__ 30th Maximum Hour Traffic		Percent Truck Traffic in 30th Maximum Hour	Estimated Percent Increase by 20__	Year 20__ 30th Maximum Hour Traffic		Estimated Percent Increase by 20__	Year 20__ 30th Maximum Hour Traffic	
	A.M.	P.M.			A.M.	P.M.		A.M.	P.M.
AB (T)									
AD (L)									
AC (R)									
BA (T)									
BC (L)									
BD (R)									
CD (T)									
CA (L)									
CB (R)									
DC (T)									
DB (L)									
DA (R)									
TOTAL A									
TOTAL B									
TOTAL C									
TOTAL D									

T = Through, L = Left, R = Right



TRAFFIC DATA SUMMARY
Figure 14-3B

14-4 INTERSECTION DESIGN STUDY PROCESSING

Intersection design studies are normally prepared under the direction of the District Geometrics Engineer. Upon completion of the IDS, it is approved by the district as illustrated in the signature block in Figure 14-2A and forwarded to BDE for final acceptance for inclusion in the Phase I report.

When projects require an IDS, the district should not conduct public involvement activities without an approved IDS. When an IDS is prepared by a certified Geometrics Engineer and reviewed according to current geometric design policies, it may be included as part of the Phase I report without advance approval by BDE. However, if an IDS contains design elements that deviate from current geometric design policies or if it has not been prepared according to current geometric engineering review procedures, submit the IDS to BDE for review and approval before including it in a Phase I report. Before submittal, obtain all appropriate signatures on the IDS and prepare a transmittal memo that summarizes the key points of the study. If a consultant has prepared the IDS, the memo also must state that the IDS has been reviewed by the district before submittal to BDE.

In some cases, concurrence in the design of an intersection by BDE may be given concurrently with design approval of the final Phase I report. This ensures the consideration of social, economic, and environmental factors and public comments that could affect the design elements of an intersection. In addition, an crash analysis and relevant collision diagrams may be reviewed concurrently with the IDS.

If intersection conditions are complex, the district, at its option, may forward the IDS to BDE for early review and approval. In this case, the IDS is reviewed with particular emphasis on compliance with accepted design practices, methods of managing or controlling access, intersection capacity, signal phasing, operational safety, efficiency, and any needed design exceptions. BDE may recommend changes to the IDS. If changes are recommended, the comments are forwarded to the district for revision. After the revised IDS is reviewed and considered satisfactory, it is then approved by BDE for inclusion in the Phase I report.

